

CLAIMS

We claim:

1. A method of determining a location of a mobile terminal, comprising:
receiving, at the mobile terminal, respective data packets from respective ones
5 of at least three transmitters whose respective locations are known, the respective
locations of the at least three transmitters being different from each other;
determining respective delays for the respective data packets to travel from the
respective ones of the at least three transmitters to the mobile terminal; and
determining the location of the mobile terminal based on the respective delays
10 and the respective locations of the at least three transmitters.
2. The method of Claim 1, wherein determining the respective delays for
the respective data packets to travel from the respective ones of the at least three
transmitters to the mobile terminal comprises determining respective distances
15 between the mobile terminal and the respective ones of the at least three transmitters
based on the respective delays; and
wherein determining the location of the mobile terminal based on the
respective delays and the respective locations of the at least three transmitters
comprises determining the location of the mobile terminal based on the respective
20 distances between the mobile terminal and the respective ones of the at least three
transmitters.
3. The method of Claim 2, wherein determining the respective distances
between the mobile terminal and the respective ones of the at least three transmitters
25 based on the respective delays comprises:
determining respective total times to transmit the respective data packets from
the respective ones of at least three transmitters and to receive the respective data
packets at the mobile terminal;
subtracting respective times to process the respective data packets in both the
30 respective ones of the at least three transmitters and the mobile terminal from the
respective total times to generate respective first results;
determining respective times for the respective ones of the at least three
transmitters to transmit the respective data packets;

subtracting the respective times for the respective ones of the at least three transmitters to transmit the respective data packets from the respective first results to generate respective second results; and

5 multiplying the respective second results by a signal propagation speed that is associated with a communication medium over which the respective data packets are transmitted from the respective ones of the at least three transmitters to the mobile terminal.

10 4. The method of Claim 3, wherein determining the respective total times to transmit the respective data packets from the respective ones of at least three transmitters and to receive the respective data packets at the mobile terminal comprises determining the respective total times to transmit the respective data packets from the respective ones of at least three transmitters and to receive the
15 respective data packets at the mobile terminal based on respective time stamp information in the respective data packets.

20 5. The method of Claim 3, wherein determining the respective times for the respective ones of the at least three transmitters to transmit the respective data packets comprises:

determining respective sizes of the data packets; and
dividing the respective sizes of the data packets by respective data
transmission rates associated with respective ones of the at least three transmitters.

25 6. The method of Claim 1, wherein determining the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters comprises:

transmitting the respective delays to a data processing system, the data processing system being programmed with the respective locations of the at least three transmitters; and

30 determining, at the data processing system, the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters.

7. The method of Claim 1, wherein determining the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters comprises:

receiving, at the mobile terminal, the respective locations of the at least three transmitters from the at least three transmitters; and

determining, at the mobile terminal, the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters.

8. The method of Claim 1, wherein the respective ones of the at least three transmitters comprise respective ones of a plurality of mobile data base stations, and wherein the received signals are cellular digital packet data (CDPD) signals.

9. The method of Claim 8, wherein respective ones of the at least three transmitters are associated with respective ones of at least three cells, wherein the mobile terminal is located in one of the at least three cells, and wherein the one of the at least three cells is adjacent to other ones of the at least three cells.

10. The method of Claim 8, wherein respective ones of the at least three transmitters are associated with respective ones of at least three cells, wherein the mobile terminal is located in one of the at least three cells, and wherein receiving, at the mobile terminal, the respective data packets from the respective ones of the at least three transmitters whose respective locations are known comprises:

scanning respective CDPD channels that are associated with respective other ones of the at least three cells, which are adjacent to the one of the at least three cells.

11. The method of Claim 8, wherein respective ones of the at least three transmitters are associated with respective ones of at least three cells, wherein the mobile terminal is located in one of the at least three cells, and wherein other ones of the at least three cells comprise at least one cell that is adjacent to the one of the at least three cells and at least one cell that is not adjacent to the one of the at least three cells.

12. The method of Claim 8, wherein respective ones of the at least three transmitters are associated with respective ones of at least three cells, wherein the mobile terminal is located in one of the at least three cells, and wherein receiving, at the mobile terminal, the respective data packets from the respective ones of the at least
5 three transmitters whose respective locations are known comprises:

scanning respective CDPD channels that are associated with respective other ones of the at least three cells, which comprise at least one cell that is adjacent to the one of the at least three cells and at least one cell that is not adjacent to the one of the at least three cells.

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13. A method of determining a location of a mobile terminal, comprising:
transmitting, from the mobile terminal, respective data packets to respective ones of the at least three transmitters whose respective locations are known, the respective locations of the at least three transmitters being different from each other;

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transmitting, from the respective ones of the at least three transmitters, respective response data packets to the mobile terminal responsive to receiving the respective data packets at the respective ones of the at least three transmitters;

receiving, at the mobile terminal, respective response data packets from the respective ones of the at least three transmitters;

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determining respective delays for the respective data packets to travel from the mobile terminal to the respective ones of the at least three transmitters and for the respective response data packets to travel from the respective ones of the at least three transmitters to the mobile terminal; and

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determining the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters.

14. The method of Claim 13, wherein determining the respective delays for the respective data packets to travel from the mobile terminal to the respective ones of the at least three transmitters and for the respective response data packets to travel
30 from the respective ones of the at least three transmitters to the mobile terminal comprises determining respective distances between the mobile terminal and the respective ones of the at least three transmitters based on the respective delays; and

wherein determining the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters comprises determining the location of the mobile terminal based on the respective distances between the mobile terminal and the respective ones of the at least three transmitters.

15. The method of Claim 14, wherein determining the respective distances between the mobile terminal and the respective ones of the at least three transmitters based on the respective delays comprises:

determining respective total times to transmit the respective data packets to the respective ones of the at least three transmitters, to receive the respective data packets at the respective ones of the at least three transmitters, to transmit the respective response data packets to the mobile terminal, and to receive the respective response data packets from the respective ones of the at least three transmitters;

subtracting respective times to process the respective data packets in both the respective ones of the at least three transmitters and the mobile terminal from the respective total times to generate respective first results;

subtracting respective times to process the respective response data packets in both the respective ones of the at least three transmitters and the mobile terminal from the respective first results to generate respective second results;

determining respective times for the mobile terminal to transmit the respective data packets;

subtracting the respective times for the mobile terminal to transmit the respective data packets from the respective second results to generate respective third results;

determining respective times for the respective ones of the at least three transmitters to transmit the respective response data packets;

subtracting the respective times for the respective ones of the at least three transmitters to transmit the respective response data packets from the respective third results to generate respective fourth results; and

multiplying the respective fourth results by a signal propagation speed that is associated with a communication medium over which the respective data packets are transmitted from the mobile terminal to the respective ones of the at least three

transmitters, and over which the respective response data packets are transmitted from the respective ones of the at least three transmitters to the mobile terminal.

16. A system for determining a location of a mobile terminal, comprising:
5 means for receiving, at the mobile terminal, respective data packets from respective ones of at least three transmitters whose respective locations are known, the respective locations of the at least three transmitters being different from each other;
means for determining respective delays for the respective data packets to travel from the respective ones of the at least three transmitters to the mobile terminal;
10 and
means for determining the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters.

17. The system of Claim 16, wherein the means for determining the
15 respective delays for the respective data packets to travel from the respective ones of the at least three transmitters to the mobile terminal comprises means for determining respective distances between the mobile terminal and the respective ones of the at least three transmitters based on the respective delays; and
wherein the means for determining the location of the mobile terminal based
20 on the respective delays and the respective locations of the at least three transmitters comprises means for determining the location of the mobile terminal based on the respective distances between the mobile terminal and the respective ones of the at least three transmitters.

18. The system of Claim 17, wherein the means for determining the
25 respective distances between the mobile terminal and the respective ones of the at least three transmitters based on the respective delays comprises:
means for determining respective total times to transmit the respective data packets from the respective ones of at least three transmitters and to receive the
30 respective data packets at the mobile terminal;
means for subtracting respective times to process the respective data packets in both the respective ones of the at least three transmitters and the mobile terminal from the respective total times to generate respective first results;

means for determining respective times for the respective ones of the at least three transmitters to transmit the respective data packets;

means for subtracting the respective times for the respective ones of the at least three transmitters to transmit the respective data packets from the respective first results to generate respective second results; and

means for multiplying the respective second results by a signal propagation speed that is associated with a communication medium over which the respective data packets are transmitted from the respective ones of the at least three transmitters to the mobile terminal.

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19. The system of Claim 18, wherein the means for determining the respective total times to transmit the respective data packets from the respective ones of at least three transmitters and to receive the respective data packets at the mobile terminal comprises means for determining the respective total times to transmit the respective data packets from the respective ones of at least three transmitters and to receive the respective data packets at the mobile terminal based on respective time stamp information in the respective data packets.

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20. The system of Claim 18, wherein the means for determining the respective times for the respective ones of the at least three transmitters to transmit the respective data packets comprises:

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means for determining respective sizes of the data packets; and

means for dividing the respective sizes of the data packets by respective data transmission rates associated with respective ones of the at least three transmitters.

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21. A system for determining a location of a mobile terminal, comprising:

means for transmitting, from the mobile terminal, respective data packets to respective ones of the at least three transmitters whose respective locations are known, the respective locations of the at least three transmitters being different from each other;

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means for transmitting, from the respective ones of the at least three transmitters, respective response data packets to the mobile terminal responsive to

receiving the respective data packets at the respective ones of the at least three transmitters;

means for receiving, at the mobile terminal, respective response data packets from the respective ones of the at least three transmitters;

5 means for determining respective delays for the respective data packets to travel from the mobile terminal to the respective ones of the at least three transmitters and for the respective response data packets to travel from the respective ones of the at least three transmitters to the mobile terminal; and

10 means for determining the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters.

22. The system of Claim 21, wherein the means for determining the respective delays for the respective data packets to travel from the mobile terminal to the respective ones of the at least three transmitters and for the respective response
15 data packets to travel from the respective ones of the at least three transmitters to the mobile terminal comprises means for determining respective distances between the mobile terminal and the respective ones of the at least three transmitters based on the respective delays; and

20 wherein the means for determining the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters comprises means for determining the location of the mobile terminal based on the respective distances between the mobile terminal and the respective ones of the at least three transmitters.

25 23. The system of Claim 22, wherein the means for determining the respective distances between the mobile terminal and the respective ones of the at least three transmitters based on the respective delays comprises:

means for determining respective total times to transmit the respective data packets to the respective ones of the at least three transmitters, to receive the
30 respective data packets at the respective ones of the at least three transmitters, to transmit the respective response data packets to the mobile terminal, and to receive the respective response data packets from the respective ones of the at least three transmitters;

means for subtracting respective times to process the respective data packets in both the respective ones of the at least three transmitters and the mobile terminal from the respective total times to generate respective first results;

means for subtracting respective times to process the respective response data packets in both the respective ones of the at least three transmitters and the mobile terminal from the respective first results to generate respective second results;

means for determining respective times for the mobile terminal to transmit the respective data packets;

means for subtracting the respective times for the mobile terminal to transmit the respective data packets from the respective second results to generate respective third results;

means for determining respective times for the respective ones of the at least three transmitters to transmit the respective response data packets;

means for subtracting the respective times for the respective ones of the at least three transmitters to transmit the respective response data packets from the respective third results to generate respective fourth results; and

means for multiplying the respective fourth results by a signal propagation speed that is associated with a communication medium over which the respective data packets are transmitted from the mobile terminal to the respective ones of the at least three transmitters, and over which the respective response data packets are transmitted from the respective ones of the at least three transmitters to the mobile terminal.

24. A computer program product for determining a location of a mobile terminal, comprising:

a computer readable storage medium having computer readable program code embodied therein, the computer readable program code comprising:

computer readable program code for receiving, at the mobile terminal, respective data packets from respective ones of at least three transmitters whose respective locations are known, the respective locations of the at least three transmitters being different from each other;

computer readable program code for determining respective delays for the respective data packets to travel from the respective ones of the at least three transmitters to the mobile terminal; and

computer readable program code for determining the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters.

5 25. The computer program product of Claim 24, wherein the computer readable program code for determining the respective delays for the respective data packets to travel from the respective ones of the at least three transmitters to the mobile terminal comprises computer readable program code for determining
10 respective distances between the mobile terminal and the respective ones of the at least three transmitters based on the respective delays; and

 wherein the computer readable program code for determining the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters comprises computer readable program code for determining
15 the location of the mobile terminal based on the respective distances between the mobile terminal and the respective ones of the at least three transmitters.

 26. The computer program product of Claim 25, wherein the computer readable program code for determining the respective distances between the mobile terminal and the respective ones of the at least three transmitters based on the
20 respective delays comprises:

 computer readable program code for determining respective total times to transmit the respective data packets from the respective ones of at least three transmitters and to receive the respective data packets at the mobile terminal;

 computer readable program code for subtracting respective times to process
25 the respective data packets in both the respective ones of the at least three transmitters and the mobile terminal from the respective total times to generate respective first results;

 computer readable program code for determining respective times for the respective ones of the at least three transmitters to transmit the respective data
30 packets;

 computer readable program code for subtracting the respective times for the respective ones of the at least three transmitters to transmit the respective data packets from the respective first results to generate respective second results; and

computer readable program code for multiplying the respective second results by a signal propagation speed that is associated with a communication medium over which the respective data packets are transmitted from the respective ones of the at least three transmitters to the mobile terminal.

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27. The computer program product of Claim 26, wherein the computer readable program code for determining the respective total times to transmit the respective data packets from the respective ones of at least three transmitters and to receive the respective data packets at the mobile terminal comprises computer readable program code for determining the respective total times to transmit the respective data packets from the respective ones of at least three transmitters and to receive the respective data packets at the mobile terminal based on respective time stamp information in the respective data packets.

28. The computer program product of Claim 26, wherein the computer readable program code for determining the respective times for the respective ones of the at least three transmitters to transmit the respective data packets comprises:

computer readable program code for determining respective sizes of the data packets; and

computer readable program code for dividing the respective sizes of the data packets by respective data transmission rates associated with respective ones of the at least three transmitters.

29. A computer program product for determining a location of a mobile terminal, comprising:

a computer readable storage medium having computer readable program code embodied therein, the computer readable program code comprising:

computer readable program code for transmitting, from the mobile terminal, respective data packets to respective ones of the at least three transmitters whose respective locations are known, the respective locations of the at least three transmitters being different from each other;

computer readable program code for transmitting, from the respective ones of the at least three transmitters, respective response data packets to the mobile terminal

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responsive to receiving the respective data packets at the respective ones of the at least three transmitters;

computer readable program code for receiving, at the mobile terminal, respective response data packets from the respective ones of the at least three
5 transmitters;

computer readable program code for determining respective delays for the respective data packets to travel from the mobile terminal to the respective ones of the at least three transmitters and for the respective response data packets to travel from the respective ones of the at least three transmitters to the mobile terminal; and
10 computer readable program code for determining the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters.

30. The computer program product of Claim 29, wherein the computer
15 readable program code for determining the respective delays for the respective data packets to travel from the mobile terminal to the respective ones of the at least three transmitters and for the respective response data packets to travel from the respective ones of the at least three transmitters to the mobile terminal comprises computer readable program code for determining respective distances between the mobile
20 terminal and the respective ones of the at least three transmitters based on the respective delays; and

wherein the computer readable program code for determining the location of the mobile terminal based on the respective delays and the respective locations of the at least three transmitters comprises computer readable program code for determining
25 the location of the mobile terminal based on the respective distances between the mobile terminal and the respective ones of the at least three transmitters.

31. The computer program product of Claim 30, wherein the computer
30 readable program code for determining the respective distances between the mobile terminal and the respective ones of the at least three transmitters based on the respective delays comprises:

computer readable program code for determining respective total times to transmit the respective data packets to the respective ones of the at least three

transmitters, to receive the respective data packets at the respective ones of the at least three transmitters, to transmit the respective response data packets to the mobile terminal, and to receive the respective response data packets from the respective ones of the at least three transmitters;

5 computer readable program code for subtracting respective times to process the respective data packets in both the respective ones of the at least three transmitters and the mobile terminal from the respective total times to generate respective first results;

10 computer readable program code for subtracting respective times to process the respective response data packets in both the respective ones of the at least three transmitters and the mobile terminal from the respective first results to generate respective second results;

computer readable program code for determining respective times for the mobile terminal to transmit the respective data packets;

15 computer readable program code for subtracting the respective times for the mobile terminal to transmit the respective data packets from the respective second results to generate respective third results;

20 computer readable program code for determining respective times for the respective ones of the at least three transmitters to transmit the respective response data packets;

computer readable program code for subtracting the respective times for the respective ones of the at least three transmitters to transmit the respective response data packets from the respective third results to generate respective fourth results; and

25 computer readable program code for multiplying the respective fourth results by a signal propagation speed that is associated with a communication medium over which the respective data packets are transmitted from the mobile terminal to the respective ones of the at least three transmitters, and over which the respective response data packets are transmitted from the respective ones of the at least three transmitters to the mobile terminal.